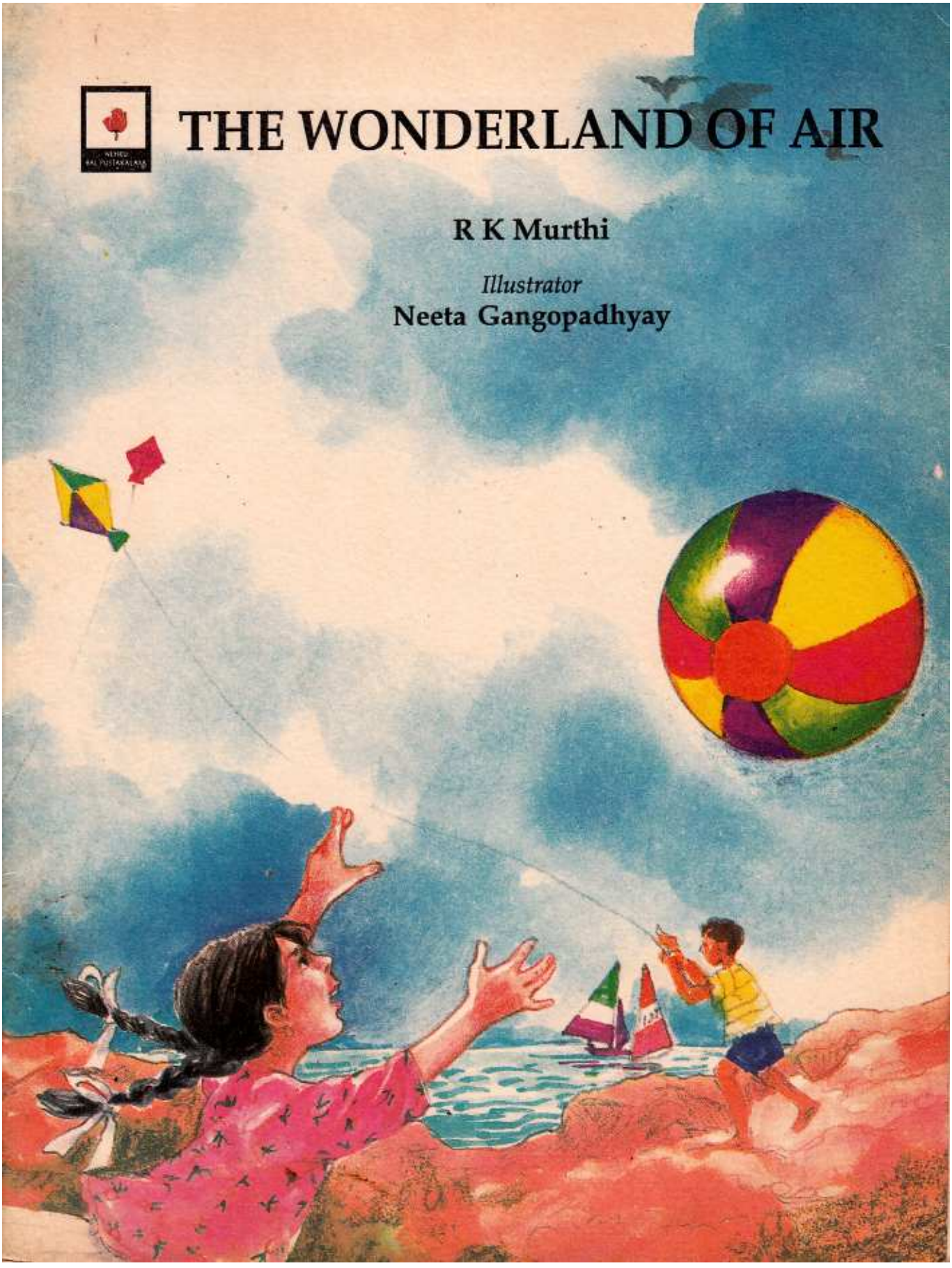
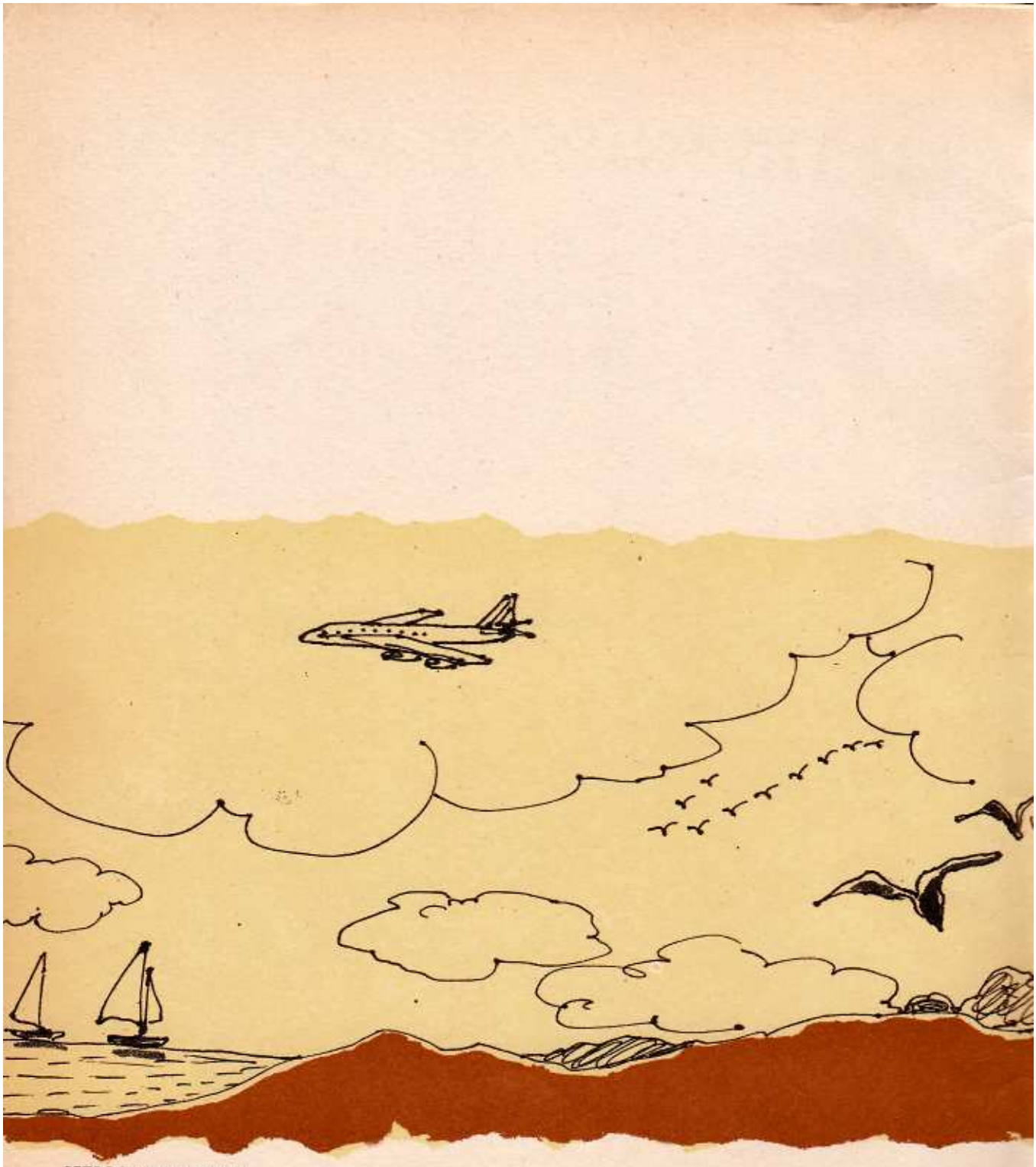
THE WONDERLAND OF AIR

R K Murthi

Illustrator
Neeta Gangopadhyay





ISBN 81-237-2822-0

First Edition : 1999 (*Saka* 1920)

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Rs 15.00

Published by the Director, National Book Trust, India
A5 Green Park, New Delhi - 110016.

Nehru Bal Pusthakalaya

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NATIONAL BOOK TRUST, INDIA

The first rays of the sun stream in, hand in hand, with a waft of air, through the half-open window. Dancing on my eyelids, they prepare me for another new morning. I open my eyes and find

my Papa and sister Shalu at my bed side. I sit up and yawn. Papa asks me, "Want to come with us to the station?"

"Who is coming?" I ask.

"Uncle Hari," Papa says.

The news cheers me. For Uncle Hari is fun to be with. I bounce out of bed, get ready quickly and down a glass of hot milk, scalding my tongue in the process. Papa hoots the horn of the car twice. I make a dash to the porch and hop into the car. "When I first met Hari, he was just a boy. A boy in half pants, a shadow of his sister, your Mamma. He was then a mischievous imp. Today he teaches at the University. How time flies!" Papa grins.

Soon we reach the station. The train rolls in and grinds to a stop. Uncle Hari alights, looks out for us. I spot him and take him to the run. Shalu and Papa come close behind. Uncle hugs us, bends and touches Papa's feet, straightens himself and picks up the suit-case.

On our drive back home, Shalu and I tell him how much we enjoyed his last visit. "Remember, you introduced us to the World of Shadows." Uncle smiles and says, "This time, I will take you to the Wonderland of Air. We will visit this world after lunch."

That rouses our curiosity. Time crawls. It seems ages before we gather around the dining table. Mamma sets up a grand lunch. The dessert... *badam kheer*... tops it all.

"Thank you, Sarada. I had just been looking for good home food. The food they serve at the canteen is so tasteless..." Uncle gets up, after a second helping of the sweet dish.

"What you need is a wife," Mamma jokes.

"Who may become just another mouth to feed," Uncle winks at Mamma.

"She may be more efficient when it comes to shutting up the Big Mouth that you are," Mamma has yet another quip.

"A Big Mouth is a windbag?" Uncle jokes, turns to us and says, "Windbag is a talkative person who boasts too much. I certainly am not a windbag."

"You think so? You can talk for hours, at a stretch. You love your own voice," Mamma raps him.

"Whose voice do you love?" Uncle Hari retorts.

"Stop teasing. I have work to do," Mamma changes track. We help Mamma clear the table. Shalu tugs Uncle's arm gently and asks, "When do we visit the Wonderland of Air?"

"Right away," Uncle leads us to the study.

Air Has Weight

"There is another ideal air upholds. It hates pride. It never throws its weight around. So we think that air is weightless. That is not true. Air is lighter than feather. But it does carry some weight. Anything that has weight applies pressure too. Air is no exception," Uncle takes a pause.

"I don't believe you," I scowl.

"I will prove that air has weight?" Uncle Hari turns to me and says, "Get me two glasses of equal height. Also fetch me a

long pencil, a rod about 40 cm. long, two small balloons and a roll of adhesive tape."

Shalu and I fan out to get the materials. Mamma raises her eyebrows, when I run into the kitchen to get the glasses. "Why do you want them? You may drop them and break them and then get hurt," she warns.

"Uncle wants the glasses. He says air has weight. Shalu and I don't think he is right. Uncle wants to prove his point. For that he needs a few things... a pencil, a short rod, two unused balloons and two glasses," I tell her.

Mamma nods her head, "Be careful. Don't be butter-fingered," mamma hands us two glasses. I wave my hands before her to show her that they carry no trace of butter whatsoever, but she ignores me.

I run back to the study, hand the glasses to Uncle and then tell him, "Mamma said I am butter-fingered."

"Did she say that? Not surprising. She likes that term. It stands for one whose hold is not very firm, one who lets things drop off," Uncle recalls an incident of his childhood. "Years ago, your Mamma tried to tell me that air offers resistance. 'Let us see how much resistance it offers when this bottle falls through space,' I told your Mamma, picked up the bottle of perfume from her hand and dropped it. Air did not resist the fall. The bottle hit the floor and broke into pieces. The contents of the bottle spilled all over. Your Mamma was aghast at the sight. She tried to hit me, but I slipped away. Then, I remember, she called me butter-fingered."

"But air has resistance?" I ask.

"Anything that has weight has resistance. The air offers resistance. But it may not always be enough to beat gravity. You must have heard of the earth's gravity. It is the force with which the earth attracts all things within reach. Grabity would be a better word for this weakness of the earth," Uncle jokes. "Did

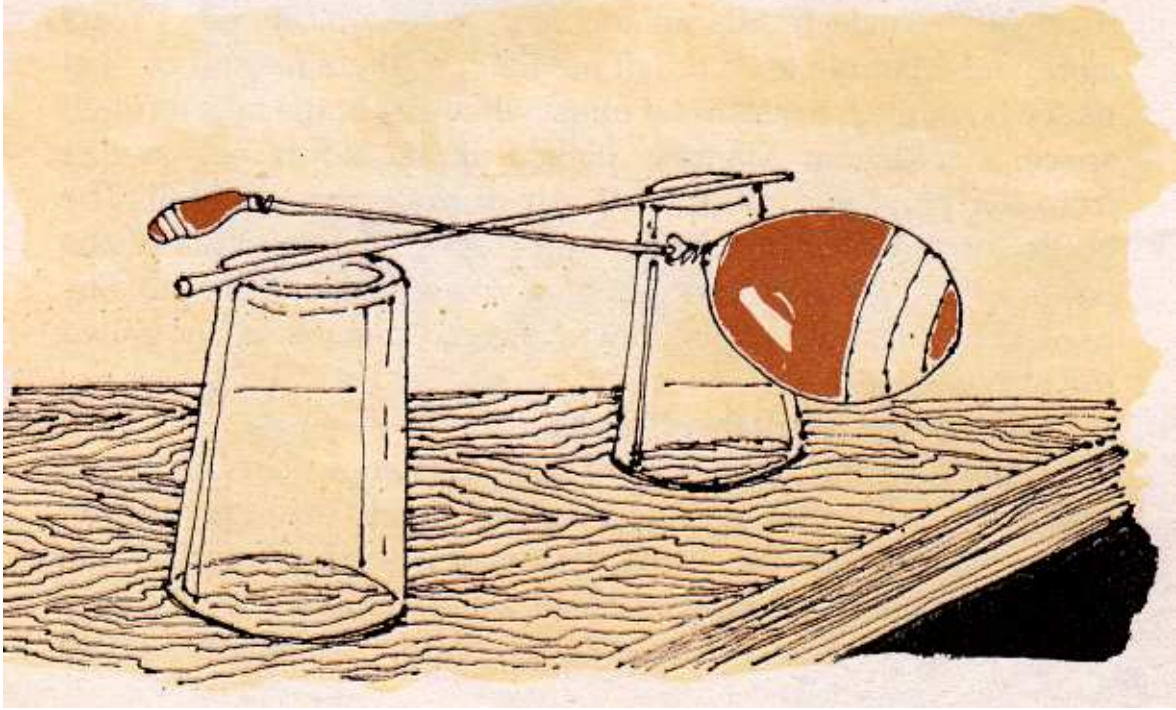
someone put a V in place of B? Do you get it? It is a pun. Pun is a fun turn we give to words. I have punned when I turned gravity into grabity," Uncle laughs.

Shalu finds us laughing loudly when she returns with the other items. She asks what the joke is all about. Uncle repeats the pun. Shalu bursts into a loud laughter.

"Enough, my girl..." Uncle silences her with a stern stare, and places the glasses upside down on the table. The pencil goes on top of them, shaping a bridge. Uncle picks up the rod, sticks the balloons, one at each end of the rod, and places the rod across the pencil. The mid point of the rod touches the pencil. The rod remains perfectly balanced.

Uncle unfastens one of the balloons and inflates it. The balloon fills up. Uncle ties up the neck of the balloon and sticks it back to the end of the rod. The end holding the inflated balloon dips down. The other end, with the flat balloon, swings up.

Uncle looks pleased. He says, "Have you watched the



common balance? The pans are evenly balanced when there is nothing in either of the pans. Place a weight on one of the pans. It dips down. So it is here too. I attached the inflated balloon on one end and... Do you get the message?" Uncle turns to us.

"Of course. The air you blew into the balloon has made it heavier. So the rod has dipped down with the weight," Shalu says.

"So air has weight," I admit.

"The weight that air exerts has been calculated. It is *about 112 kg per 100 square centimetres,*" Uncle gives us the figure.

"And yet we don't feel the weight on our backs," Shalu is puzzled.

Air Pressure

"You know why? The air presses us on all sides. The stress is evenly distributed. This pressure is very strong. I will show you how strong it is," Uncle picks up one of the glasses. He checks its rim. The rim is smooth. Uncle walks to the wash basin, while calling out to me, "Can you get me a cardboard? A square one of 6 cm would do."

I go back to my desk, search the lowest drawer and find a piece of cardboard. I check its dimensions. Then I run back to join Shalu and Uncle. He fills the glass with water, wets the rim of the tumbler, picks up the cardboard from my hand, places it on top of the glass, holds it down with his palm and turns the tumbler upside down. He says, "What will you give me if I make the cardboard hold the water up in the tumbler?"

"You can't do that. You are no magician," Shalu snaps.

"Watch the magic, my girl," Uncle takes off the hand supporting the cardboard. Shalu and I watch with bated breath. We expect the water to push the cardboard aside and splash down. But the cardboard stays in place. The water stays in the tumbler.

"That is a great magical trick," Shalu and I scream with joy.

"There is no magic in it. Air applied pressure on the cardboard from below. The pressure it applied was stronger than the weight of the water within. So the cardboard held back the water," Uncle places his hand under the cardboard, turns the glass around, removes the cardboard, empties the water into the wash basin and leads us back to the study.

"Have you ever thought of the many tricks which air pressure plays? Have you ever used an ink filler? It is a slender glass tube, narrow at the bottom. On top is a rubber cap. Press the rubber cap tight and push the lowest end of the glass tube

into a bottle of ink. Then release the hold on the cap. Ink rises in the tube. It rises because of air pressure.

"It is the same when you use a straw to drink from a bottle of soft drink. You suck at one end of the straw. The air in the straw moves up. The air from outside presses on the liquid. The liquid has only one opening. That is provided by the straw. So the drink that cheers moves up the straw to your mouth, smoothly. But not all motions are smooth," Uncle picks up a small balloon and blows into it through the narrow neck. The balloon fills up. Uncle imprisons the air in the balloon by pressing the neck down with the thumb and the index finger. He holds it at eye level. Quickly he takes off his fingers. The balloon zigzags, changes direction, swings up and down. It loses all the air within and falls to the floor.

We enjoy that show. "Do you know why the balloon moved wildly?" Uncle asks. Shalu and I keep mum. Then Uncle explains, "The air I blew into the balloon is compressed. The space is cramped, limited. Who likes to stay in a crowd? Not humans. Not air, either. It wants to get out. So long as I held the neck tight, the air could not find a way out. The air waited. The moment I took my fingers off, the air within pushed against each other. The air closest to the neck rushed forward. The forward thrust pushed the balloon backwards. So it moved back. Since the neck was free, the air changed direction as it came out. As a result the balloon also changed direction; it zigzagged, moved up and down. It moved like a drunk," Uncle pauses, before picking up the balloon and blowing into it again.

"Can I have a thread; and a pencil with a sharp tip?" Uncle puts in his demand.

I fetch the items. Uncle ties up the neck of the balloon. The air is now imprisoned in the balloon. Uncle pricks the balloon with the sharp end of the pencil. The balloon bursts, with a popping sound.

"Why did you do that? You killed the balloon," I joke.

"That is no crime," Uncle jokes. Then he adds, "I did that to show you that air never gets hurt. The air inside the balloon waited for any outlet. The pinhole provided the outlet. The air pressed forward, gained the power to destroy the balloon and managed to get out, all in one piece. Air gets out by destroying the barriers. Man can't always do that. I can give you the scene. The stadium where the finals of a soccer match is held is packed to capacity. The game warms up. One team scores. The supporters of the other team start heckling. The fans of both the teams hurl abuses. One group throws bottles. The other group reaches for bricks. Most spectators see danger. They rush for the exit gates. The result is a stampede. Many people die. For the walls of the stadium do not come down, like the wall of the balloon. Get the scene? What happens when an inflated balloon is pricked is almost similar. Yet there is a difference. Air gets out of a stampede unhurt. Man, alas, can't do that," Uncle grins.

"So air has weight and applies pressure. Yet we can't see it," Shalu thinks that odd.

"Want to see air! Just fetch me an empty bottle, with a narrow neck," Shalu finds one quickly. Uncle leads us to the bath room. There is a bucket, with water. Uncle pushes the bottle in. It resists. Uncle pushes it till it is completely submerged. We hear gurgling sounds. Bubbles form on the surface of the water. "They are air bubbles," Uncle smiles.

More and more bubbles appear. Soon, the gurgling sound ends. No more air bubbles appear. The bottle is filled with water.

"Where did the air come from?" Shalu wants to know.

"From the bottle," Uncle is quick to point out.

"But the bottle was empty," Shalu points out.

"When we say something is empty, we actually mean it holds nothing but air. So long as air is free to occupy space, it keeps its balance. Upset that balance and it comes down with

all the power its pressure can command," Uncle rouses our interest with that comment.

"Can you show us how air does that?" I challenge Uncle to prove his point.

"For that, we must find a tin can with a tight lid. May be I can find one in the kitchen," Uncle moves with Shalu and me on trail. We walk by the door of the bed room. Mamma is asleep. "The kitchen is all ours," Uncle speaks to us in a low voice, making us believe we are conspirators, getting ready for some weird act.

It does not take us long to find a tin with a strong lid. Uncle

turns it around, checks that the lid provides a tight fit and grins. "That would do," he mumbles, picks up a large vessel, fills it with water and lets the water boil on the gas oven. The water begins to hiss and roll. Uncle turns off the fire, places the tin, without the lid, in the boiling water. He waits for a couple of minutes. Quickly he lifts the tin off the boiling water and seals the tin with the lid. Then he draws a little distance away from the tin, taking us with him. His eyes are set on the tin. We do not know what he is waiting for.

Then we see a miracle. The tin rasps. Some invisible force is pressing it from all sides. The weakest points of the tin cave in. The tin loses shape. It now looks twisted and turned and squeezed.

"It looks like a car that had been involved in an accident. But what caused the mishap to the tin? Can you guess?" Uncle expects us to find the reason.

"You tell us," Shalu throws up her hands.

"Well, you know that heat expands bodies. The air in the tin expanded due to the heat from the boiling water. The tin could not contain all the expanded air. So some air escaped through the opening. Then I took the tin away from the boiling water and put the lid back in place. The air which remained in the tin cooled. It spread out to occupy all the space. This led to loss of pressure. The air from outside wanted to get in. It looked out for an opening. The lid stood in the way. The air then pressed the tin on the sides, with normal pressure. The air within resisted. But it was an unequal struggle. The air outside commanded more pressure than the air within. The tin's walls gave in. The air from outside pushed. The tin got squeezed. The air within now had much lesser space. With reduction of space, the air pressure increased. When the air pressure inside became equal to the air pressure outside, the two sides became equally matched. There was no more pressure on the tin. And the tin did not suffer any more," Uncle explained at length.

A Mixed Bag

"My God! I never though air is so powerful," Shalu is stunned.

"Yet air does not usually throw its weight around. It does not even remind us that we owe our all to it," Uncle peers at us.

"We owe our everything to Mamma and Papa," Shalu pouts her lips.

"How can you leave me out?" Uncle Hari fixes Shalu down with a stern stare.

"Sorry, Uncle. I know I owe much to you. But I owe nothing to this thing called air. It has no shape, no form, no smell, no taste...." Shalu does not complete the sentence.

"We owe our all to air. Air is a mixture of gases. 78 per cent of this mixture is nitrogen. Keeping it company is a very active gas, oxygen. 21 per cent of air is oxygen. Every time we inhale... I mean, when we take in air... oxygen moves in. Oxygen goes with the blood, to every part of our body. It purifies every nook and corner and collects all the carbon waste. Then we exhale... breathe out... carbon dioxide," Uncle explains.

"Breathing comes to us naturally. We never even feel it," I note.

"Except when one is old and is sleeping," Shalu scores a point.

"What do you mean?" I raise my voice, while giving her a stern look.

"Have you watched grandma? Often, when she sleeps, she makes weird noises. Her chest puffs up and I hear the sound. Her chest sags. And once again I hear the notes. With every breath, she produces those rasps," Shalu explains.

"You naughty girl! I will tell your grandma..." Uncle makes a threat, but Shalu knows, from his tone, that he is not serious.

Then he continues, "Old people snore. The snore is nothing but air making noise as it gets in or runs out of the wind pipe."

"The air does that only when Grandma is asleep. Not when

she is awake," I point out.

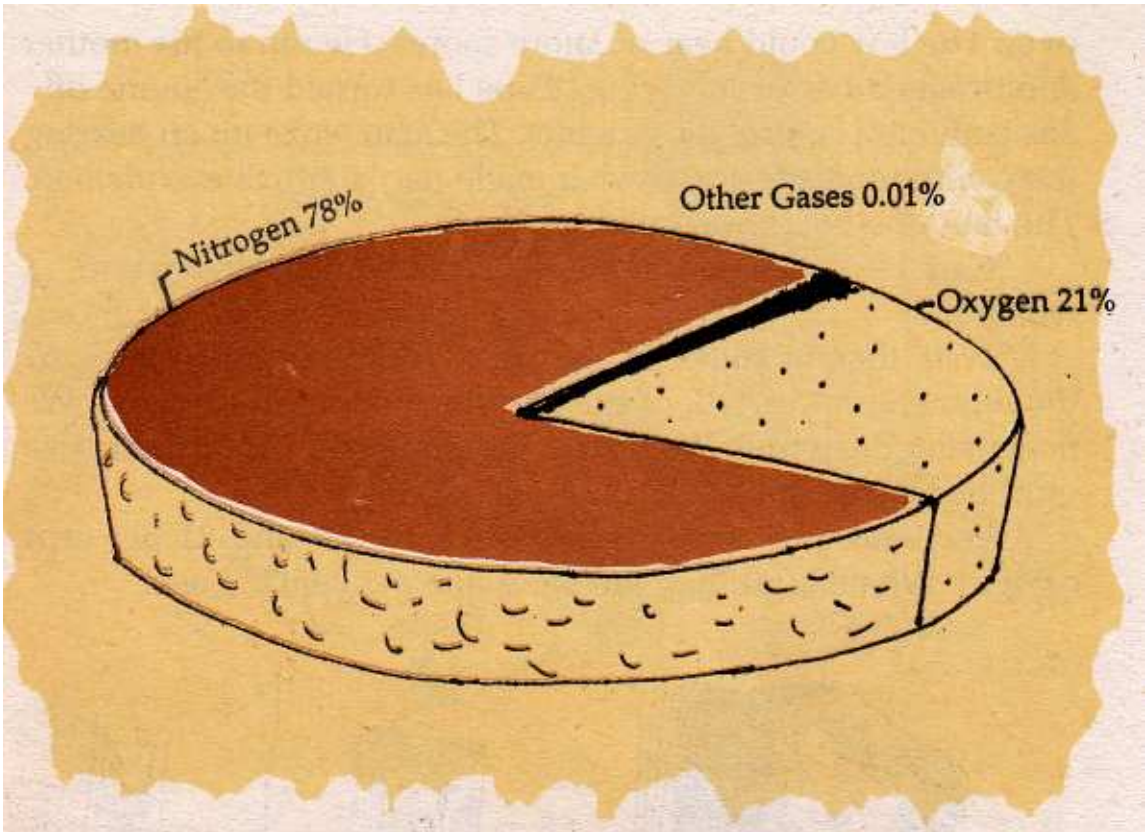
"That reminds me of a story. There was a little boy of five. One afternoon, the father took the boy to bed with him. 'Let us take a nap,' the father said. The boy nodded his head. The two lay down. The boy did not get sleep. His father slept off. Soon, the boy heard the snores. He did not know what caused the sounds. But it was fun, listening to the rise and fall of the snores. There was a rhythm in the sounds. Then the father turned

over. The boy could hear no more snores. He ran to his mother and dragged her over, saying, 'Papa has turned the engine off.' She could not control the laughter. The man woke up on hearing the commotion. He asked what made her laugh. She explained. The man too burst into laughter."

"Can I call snores breathing notes which air strikes?" I wonder.

"Well, there is music in the air. I will come to that later. At the moment, let us talk of the air which is essential to life. We never stop breathing. We take in the first breath at birth. It lasts until our last breath,"

"You said that air is 78 per cent nitrogen and 21 per cent oxygen. What about the remaining one per cent?" I ask.



"There are traces of other gases, including carbon dioxide, hydrogen, helium and methane. Also some water vapour. Together these form 0.01 per cent of the air mixture. Argon forms 0.99 per cent of all gases in the air. Argon is a very inert gas. (Anything that is bone lazy and inactive is said to be inert).

Atmospheric Layers

"We live at the bottom of a sea of gaseous air. This ocean of air has a name. Do you know what it is?" Uncle wants us to try.

"Atmosphere," Shalu and I give the answer together.

"Do you know where the name comes from? One can trace it to the Greek word for a *ball of air*. The atmosphere is hundreds of kilometers thick. It has many layers."

"Is it something like the onion? Peel one layer and there is one below. Rip it off and another layer appears," I share this

thought with Uncle and Shalu. I think it is highly original.

"Did you think it up on your own? If so, I commend you," Uncle pats me on the back and then reverts to the main theme. "I was telling you about the layers of the air above us. These layers are not clearly marked."

"They are imaginary lines, like the Equator, or the Tropic of Cancer, or the Tropic of Capricorn," Shalu rolls her eyes.

"You said it. The first layer is closest to the earth. It extends upto 15 km. Here the air is very active and works much of its miracles. Temperature swings sharply; clouds glide in and out; snow storms and blizzards are born; winds turn from friends into foes in seconds. So we get infinite variety in the weather conditions. This variety makes our earth so spicy. Rightly has it been said, 'Variety is the spice of life.' Change is what provides variety. Scientists noted the changes which mark the lowest layer of the atmosphere. They named this layer the troposphere, taking the Greek word for the *sphere of change*. Temperature drops as we go higher and still higher.

"Balloons helped confirm this fact. Balloons need upward thrust. This thrust comes from the air. For balloons are filled with either hot air; or hydrogen or helium. Hot air is lighter than cool air. So are helium and hydrogen. So the air around pushes the lighter balloon, higher and higher. The balloon goes with the wind. Remember, wind is nothing but air in motion.

"The balloons reach great heights. Often they carry gadgets to measure temperatures at various heights. Thus we learn about the link between height and temperature. As we move higher, temperature decreases. At the outer rim of the troposphere, the temperature drops down to -155 degrees Fahrenheit. Can you imagine how cold it is at this height?" Uncle waits for our reply.

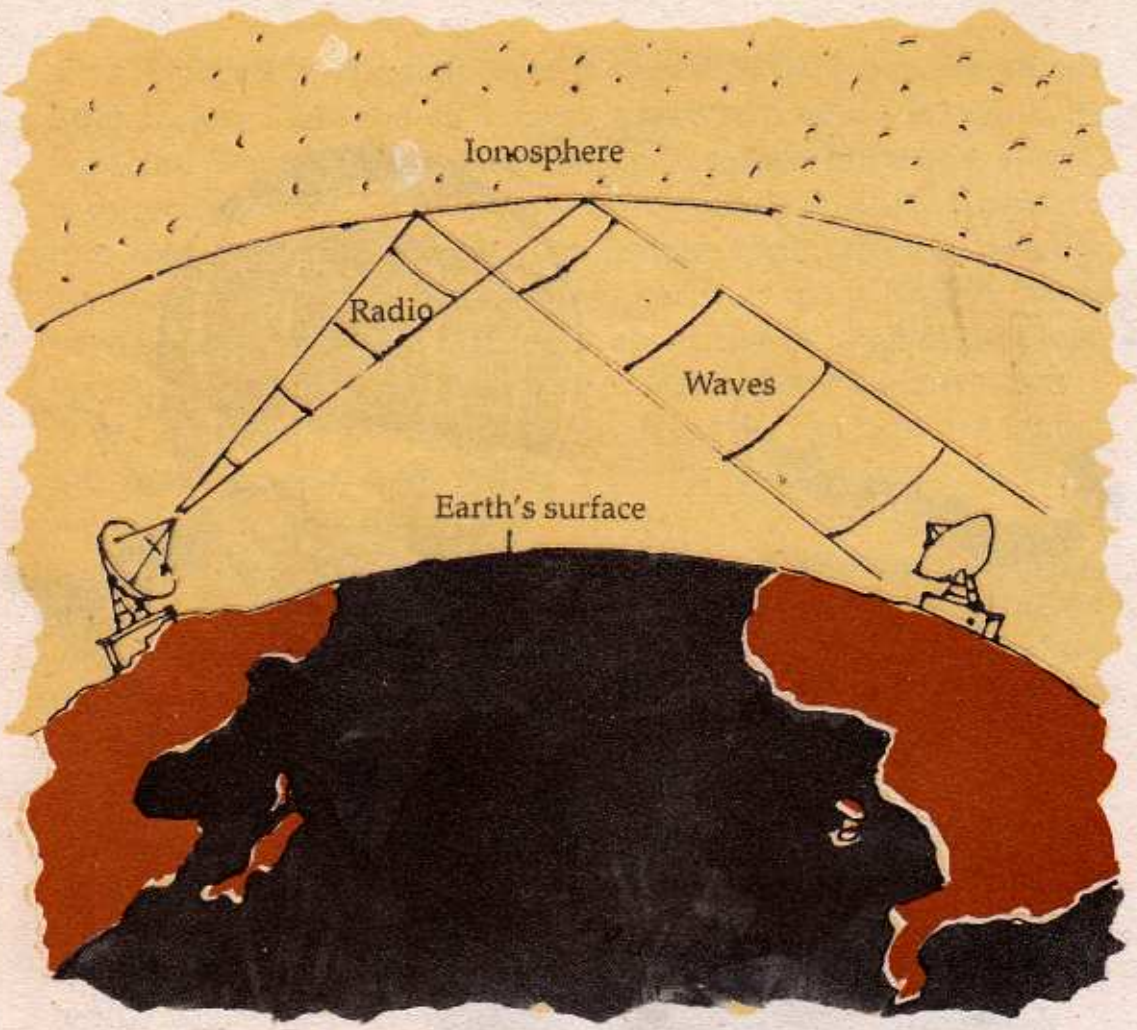
"The very thought makes me shiver," Shalu says.

"I don't find you shivering or quivering," I point out.

"You have a quiver full of words to fight," Uncle raps me, before resuming his narration. "The air beyond the troposphere is very thin. The layer is about 80 km thick. It is known as stratosphere which in Greek stands for the *sphere of layers*.

"The third layer is the ionosphere. It is about 250 km thick. Beyond that lies outer space..." Uncle takes a break and then asks, "Do you know why the third layer is called the ionosphere? The tiny particles here are special. They are hit continuously by

sun's radiation which knocks off electrons from the gas molecules leaving them in a charged, electrically active form called ions. Ions are known for their alertness. Radio waves go beyond the troposphere and the stratosphere, but they bounce back to earth when they encounter the ionosphere. Thus the radio waves, especially short waves, bounce back and forth, circling the earth

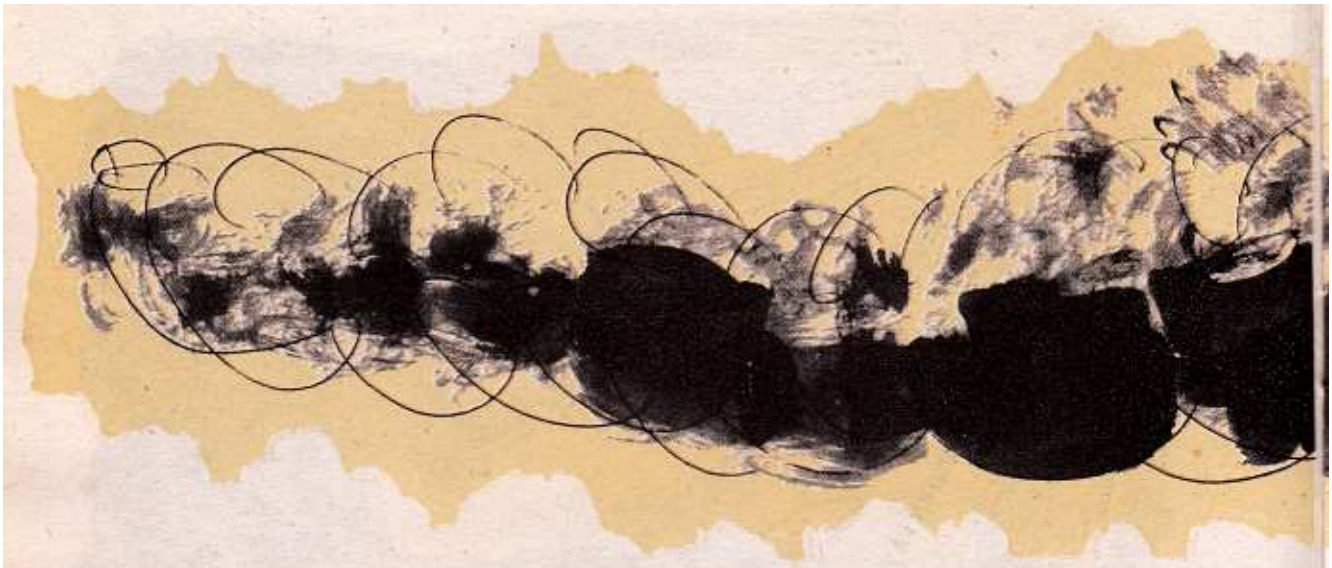


and transmission in one part of the globe reaches other parts of the globe. Thank the ions. But for them, the radio waves would stray away and all communication would come to a stand still," Uncle gives the ions due credit.

"Ions deserve a big hand," I clap my hands.

"As much as the ozone layer," Uncle continues. "Ozone is nothing but a form of oxygen. Sunlight runs into the oxygen, in the higher layers of the stratosphere. The oxygen gains more energy. This increased energy changes the oxygen into ozone. The ozone forms a belt at a height of about 25 km above the

Ultra violet rays
Ultra violet rays
Ozone
Ozone
Ozone
Ozone



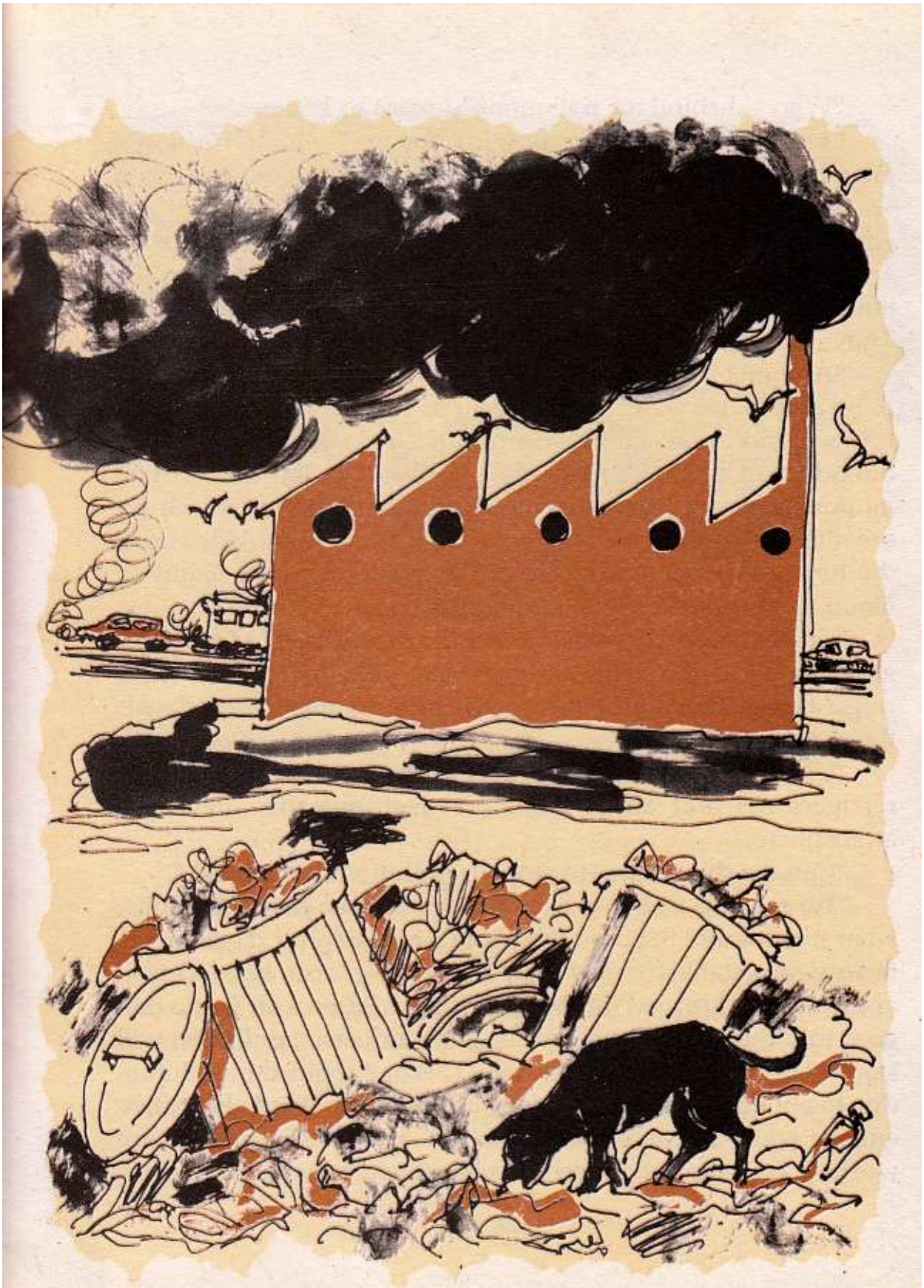
earth. You can look upon this zone as a border check-post. Or, better still, as a huge filter. We know that a filter holds back what we don't want. Often it arrests dangerous microbes. The ozone belt does just that. Sun's rays bring with them ultra-violet rays. These rays are harmful to life on the earth. The ozone filters them out. It lets the sun's rays only after this filtering.

"Oxygen is our best friend. It goes into us to purify our system. It takes up guard duty, at the check post, in the form of ozone, and stops dangerous ultra-violet rays from continuing the journey further down," Shalu is proud that she has got the facts right.

Air Pollution

"The ozone layer is the protective shield of the earth. Can I call this layer the Knight of Ozone? I remember King Arthur and the knights of the Round Table.

"The ozone layer is the protective shield. Alas! Pollution is weakening the shield. It is also weakening us," Uncle lowers his voice.



"Who is behind air pollution?" I want to know.

"Man. Pollution began with the growth of industry. Historians speak of this as the Industrial Revolution. Have you watched the chimneys of factories or power plants? The chimneys spew gases like carbon dioxide and sulphur dioxide and nitrogen dioxide into the atmosphere. This leads to smog and acid rain. When we breathe, the poison enters our body. They corrode the lungs. We develop breathing trouble.

"Automobiles burn up fuel. Mostly the fuel used by industry or by automobiles are gasoline, coal or oil. They are all different forms of carbon. When they are burnt, a large quantity of carbon dioxide and carbon monoxide escapes into the air. Carbon monoxide has no odour, no colour. It becomes part of the air we breathe. Every time we breathe, some carbon monoxide enters the lungs. The gas attacks the blood and reduces the ability of blood to transport oxygen around the body.

"The exhausts of vehicles also throw out lead. Many toxic gases are released into the air by modern industrial plants. These cause cancer. They affect the reproductive organs," Uncle details the danger.

"Chemicals called chlorofluoro carbons which are used in refrigerators and air-conditioners destroy ozone in upper atmosphere."

"Can we do nothing to stop air pollution?" Shalu asks.

"We can. The trick is to recycle the poisonous gases. You know what that means? Suppose the waste gas is sulphur dioxide. The factory can establish a new unit. The waste gas can be processed at the unit and turned into sulphuric acid. Almost all waste that goes into the air can be recycled. Then industrial pollution will stop," Uncle smiles and continues. "What about the pollution due to automobiles? Limit the use of petroleum. Find alternative energy sources. Many scientists, all around the world, are working on battery-operated or solar-powered vehicles."

"When will these cars be on the roads?" I enquire.

"Hopefully in another ten years," Uncle replies.

"That will be when I get a job. You know the first thing I will buy? A non-polluting car. Thus will I save the air," I talk of the future.

"The future is not ours to be. Think of the present. Do something to save our earth from pollution. Don't take air for granted. We have to keep it free of pollution. All of us can help the cause. It is quite easy. If only each of us plant four or five trees!" Uncle gives us a tip.

"How will that help?" Shalu looks up to Uncle for further details.

"Trees help reduce air pollution, specially in reducing the carbon dioxide in the air. Do you know what carbon dioxide is? It is a compound of carbon and oxygen. The leave of plants and trees have a magic coating. It is known as chlorophyll. Carbon dioxide breaks into carbon and oxygen when the magic coating goes to work during the day. The plants and the trees keep the carbon to produce grains and nuts and fruits. The oxygen gets back into the air. This process is known as photosynthesis," Uncle informs us.

"Will this oxygen travel 25 km up into the sky and strengthen the ozone layer?" I ask.

"Oxygen does not turn readily into ozone. So we have to protect the existing ozone layer. We know what causes damage to the ozone zone. The main culprit is chloro fluorocarbon... a compound of chlorine, fluorine and carbon... widely used in industry, specially in the field of refrigeration. Many nations have banned the use of chloro fluorocarbons after the year 2000. Harmless substitutes are under trial now. Golden days are ahead of us... days of unpolluted air, clear sky, clean water, healthy surroundings," Uncle paints a golden era.

"That sounds like music to my ears," Shalu goes poetic.

Airy Notes

"There is no music without sound. And there is no sound without air," Uncle provides a new angle to the topic.

"Are you not giving more credit to air than it deserves," I sneer.

"No praise is too high when it comes to air. If there is no air, you won't hear a word of what others say. Nor can others hear what you speak. Sound needs a medium to get across. Air provides that. I speak. The sound hits the air closest to my mouth. The air vibrates. The vibrations move along. Very much like ripples that form on water in a pond when a stone is thrown into it. Sound waves move farther and farther. The air vibrates less and still less as the waves move farther. That is why we hear better when we are close to the source of sound," Uncle explains.

"That is interesting. We speak. Our words go vibrating through the air. All the way to the listener," Shalu's eyes have a strange gleam.

Uncle gently pinches Shalu's cheek and continues, "Air not only carries sound around, but produces sounds too. Have you ever tried to blow air over the cap of a fountain pen?" Uncle pulls out his fountain pen, removes the cap, holds it close to his lips and blows. We hear a sharp whistle.

"That is not something new. Caps of pens have whistled for us, often," I blurt out.

"Once, I found an empty bottle with a narrow neck. I held the rim of the neck on line with my lips and blew along the rim. The bottle let out a sharp hoot," Shalu speaks of her experience.

"The whistle or hoot is nothing but the rush of air," Uncle notices the look of surprise in our eyes and adds, "There is air everywhere. It is there in the cap of the pen. When I blow along the rim of the cap, some air flows along the top. The rest of the air goes into the cap. The air in the cap protests. 'Don't come in. The space is just enough for us. If you come in, it will become overcrowded.' But the air I blow forces its way in. Some of the air within is pushed out. The melee creates vibrations. The vibrations turn into whistles. They may have very little variation. Yet there is music in them," Uncle notes.

"Where then comes the variation in the notes? Mamma tells me that all music is built on the *saptaswara*... the seven basic notes *sa, ri, ga, ma, pa, da,* and *ni*.... How does air produce the seven notes?" Shalu seeks an answer.

"The note is dependent on the pitch. The pitch depends on the length of the air column," Uncle notes that we have difficulty in following his words. He asks me and Shalu to fetch bottles of different heights.

Shalu and I know where we can find them. At the back of our house stands a small room. It is a sort of hold. Here one finds an assortment of articles which are not in daily use. Shalu and I run to the room. It takes us some time to find the bottles

with different heights. We place the bottles in a cane basket and run back to Uncle.

Uncle scowls after setting eyes on the bottles. They are dusty. I get the cue. In an instant, I produce a duster. I clean up the bottles, arrange them according to their heights. Uncle approves my action.

"Thank you," he says. Then he picks up the tallest bottle. He tells us to listen, carefully, to the sound he would produce by blowing along the rim of the bottle. Then he holds the rim against his lips and blows air along the rim. The sound is not very sharp. Then he picks up the bottle next in order of height and blows. The sound is sharper. He does that with three more botties, each one of lesser height than the previous one. The whistles get sharper.

Uncle puts the last bottle away and says, "There is air in the bottle. The bottle with the maximum height holds more air. The air column is longer. So it vibrates slowly and the sound is not sharp. Now you know why the bottles gave different types of whistles, when I blew into them," Uncle says.

"Should one end of the bottle be closed? What happens if I blow into a tube, open at both ends?" I raise a point.

"The air within the tube vibrates at a point called the node. The bottle's bottom is the node. In any tube, one of whose ends is sealed, the node lies at the end. In the case of an open tube, the air column vibrates with an artificial node. This node is the mid point of the tube. That leads to one basic truth. Take a tube, both of whose ends are open. Measure its length (Say 50 cm). Take another tube, of equal diameter, which is half in length to the first tube, (In this case it will be 25 cm). Seal one of its ends. Now blow into the tubes. The pitch will be the same. What does that tell us?" Uncle wants us to come up with the answer.

It takes me just a minute to get the right idea. I shout, "The pitch of a pipe, open at both ends, is same as the pitch of a pipe

of half its length with a sealed end."

"You said it," Uncle pats me. Then he says, "The power of air to produce musical notes was known to early man. He picked up bamboo pipes of different lengths to produce different notes. Even today, the Mexicans use a strange musical instrument, the bamboo pan pipe. It is a collection of bamboo tubes, of different lengths, put together. The instrument slides against the lips. The player blows into the instrument, sliding it back and forth, so that he has the right tube at his lips at any given moment," Uncle peers at the bottles and says, "Have you seen the flute?"

"I have watched Hari Prasad Chaurasia playing the flute," Shalu replies.

"The flute is a tube. It is open at both ends. It has round holes, placed at different points. The player blows air into the tube. He adjusts the pitch by suitably opening or closing the

holes on the tube. The flute is finely tuned with the help of the holes. Each hole has a link with one of the basic notes. Thus all the seven notes are there for the flautist to get. So he has no difficulty in playing any tune or raga. The *shehnai* or the *nadaswaram* or the clarinet or the saxophone or the bag pipe, as much as the conch and the horn, produces notes when we make the air in the instrument vibrate. And we hear the blend of the pitches as sweet music," Uncle gives a new insight into the mastery that great artists display.

"But there are other musical instruments... say, the *jalatarangam* or the *tabla* or the *mridangam*," I want to know whether they too produce musical noes with the help of the air.

"Have you noticed the *jalatarangam*? The player sits before identical bowls. Each bowl holds water, though the quantity of

water in each one is different. The rest of the space is occupied by air. The volume of air in each bowl in different. The bowl is hit by a stick. The shell of the bowl vibrates. This air in the bowl too vibrates with the notes. And we hear the note, one of the basic notes of music, which the bowl in planned to produce. The bowls collectively become the *jalatarangam*. The artiste can play all the ragas and songs on the *jalatarangam*. The *tabla*, the *mridangam*, the drum are percussion instruments. These instruments have processed animal skin fixed on the sides which vibrate. The artist runs his fingers over the skin; or uses a stick to beat notes. He knows the pace at which his fingers or stick should hit. He produces all the basic notes by striking the right spots. The skin vibrates. The air picks up the notes, lets the notes move along like..." Uncle pauses.

"... ripples on the surface of a pool," I complete the sentence.

"I talked about the drum. Drum is an essential part of any band group. Not so essential is the bagpipe. How does the bagpipe work? It has a bag which holds air. It has pipes, fitted into it. The piper blows air into the bag and then pushes the air into the pipes. He varies the notes by adjusting the pitch. Thus he produces soulful music. He gets the best out of captive air. So does the one who plays the harmonium." Uncle stresses the word captive.

Compressed Air

"So air can be caught, held in prison? Air is not clever enough to be free," Shalu jokes.

"Air is clever. But man is cleverer. He captures air and makes it perform many tasks. Have you seen the ironsmith at work? He needs fire to heat the metal. Air keeps the flame alive. How does the smith do that? Look around his work place. You will spot bellows. The air goes into the bellows, becomes captive. When the bellows are pressed, air is pushed out. It has only one

escape route. That is in line with the fire. So the air rushes out and fans the fire.

"I filled a balloon with air and made it captive for a second by holding the balloon's neck firmly between my thumb and index finger. Then I took my fingers off. The balloon flew around, turning and twisting. That was how I made air work for me. Do you know that air often takes us for a ride," Uncle chuckles to himself.

"We are not fools. Nobody takes us for a ride," I object.

"Don't be cocksure. Air has taken all of us for rides," Uncle notices the puzzled look in our eyes and laughs. "Air doesn't make fools of us. It just serves us. For example, you want to go to school. You run to the bicycle. You check the tyres. If it is

hard and firm, you are happy. Otherwise, you reach for an air pump. You fix the nozzle of the air pump against the mouth of the tube. Within the tyre lies the tube. You pump air into the tube. The tube begins to bulge and press against the walls of the tyre. You press the tyre. It is now hard. You pull the nozzle of the pump away from the mouth of the tube. The air stays imprisoned. Why? Because there is a valve, at the mouth of the tube. It lets air enter. But when air tries to get out, the valve blocks the exit. So the air stays within. The tyre is now ready for the drive," Uncle tells us something we do every day.

"All vehicles... motorcycles, cars, buses, trucks.... roll on tyres," I react.

"You have omitted aircraft. They too move on tyres at take off or landing. Captive air gives strength to the tyres. It is captive air which entertains us. Take the game of football, basket ball, or volley ball, for example. The ball has two coats. The outer shell sags. Within the shell lies the tube. When air is pumped into the tube, the outer shell begins to stir. Some of the creases vanish. More air goes into the tube. The outer shell gains spherical shape. More air is pumped in. Now the shell is firm and hard. The neck of the tube is sealed. The ball is now ready to take in all the kicks and bounces. We have real fun, but we forget that we owe the fun to air. Captive air," Uncle has the facts.

"Man is the master of all things. Even air," Shalu observes.

"I have not yet finished with the tasks captive air does. Air retains heat or cold. The right term for that is insulation. Why do you wear a layer of clothes on winter days? Air is trapped in the layers of the clothes. The air retains the warmth. You can test it. Heat water in two jugs. Place one of them in a cardboard box, which is lined with shredded paper or hay or old clothes; the second one without any protective cover. Test the temperature of water in the two jugs after ten minutes. The water in the first jug will be warmer than the one in the second jug. This is because..." Uncle leaves the sentence incomplete.

"... because the air in the cardboard box acts as an insulator," I am quick to offer the right answer.

"Captive air saves life too. In western nations, many cars have air-bags. They remain flat, but fill up with air, instantly, if the car collides with another car or hits an obstacle. Thus the driver/passenger in the front seat is not thrown forward and he does not hit the steering rod or the glass panels and get hurt," Uncle gives us yet another instance where captive air acts as a friend.

"We get bumps on our heads when vehicles run over rough

roads. The air does not protect us," I groan.

"There is nothing like a perfectly smooth drive. Even trains do not provide such travel. Not the trains of present days. But some day soon, we may have trains gliding on air cushions. What produces the air cushion? Magnets. The railway track is lined with electro-magnets. These magnets spring alive when the coaches, mounted on electro-magnets, rush along. These magnets have like poles. Like poles, we know, repel each other. The track and the coaches repel each others. They leave a belt of space in between. This belt is filled by air. This air provides the cushion. Trains glide over the cushion. This is known as magnetic levitation. Cars too may glide on compressed air. Then will come days of smooth movement," Uncle gives us a whiff of hope.

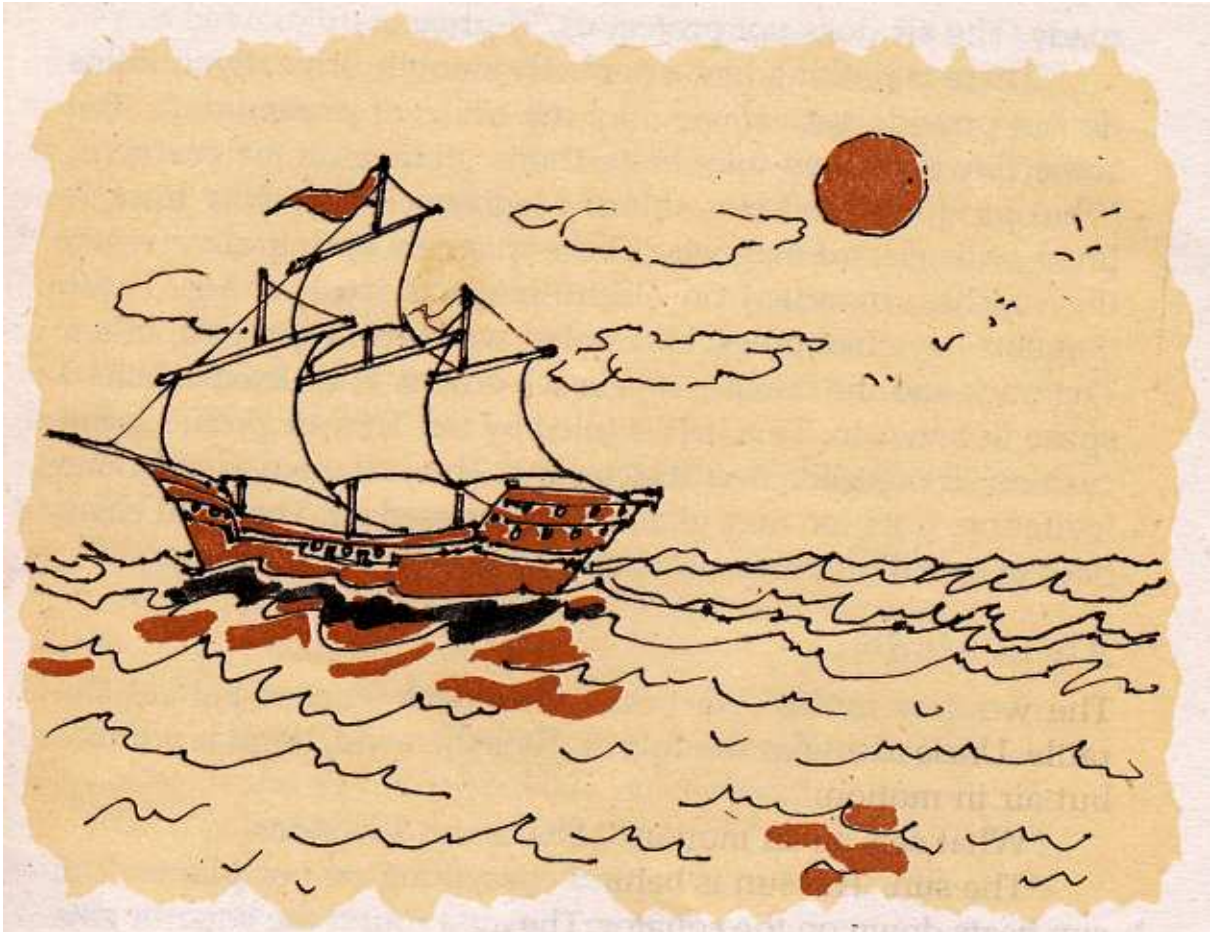
Air in Motion

The window rattles. We turn to find out what is behind the rattle. Uncle identifies the culprit. "It is the wind. Wind is nothing but air in motion."

"What sęts air in motion?" Shalu and I wonder.

"The sun. The sun is behind everything on our planet. The sun beats down on the equator. The air a round the equator gets heated up. The balance of air pressure gets disturbed. Nature steps in to restore the balance by setting air currents in motion. The hot air rises. Cool air occupies the space. This process continues, endlessly. Where the equation in perfect, the air stands still. And a doldrum is produced. When the hot air reaches a height of 8 to 10 km, it spreads out, moves toward the north pole or the south pole. As it moves, it loses much of its heat. By the time it covers one third the distance to the pole, it is so cool that it begins to sink back. This region of sinking air is called horse latitudes..."

"Horse latitudes? How did the region get this name?" I query.



"This region does not have enough air movement. In olden times, sailing ships depended on winds to cross the high seas. These ships transported men and goods; and also animals, specially horses, needed for cavalry. The ships sailed with the wind. They ran into trouble in the region of high pressure. The high pressure was caused among others by sinking air. The wind lacked enough thrust to push the ships forward. This delayed their progress. At times the delay was prolonged. The ships did not have enough provisions for the horses on board. So the animals starved to death. This is the story behind the name *horse latitudes*," Uncle has a tale to tell.

"I know why it happens. What else can sinking air do? It can only sink the hopes of sailors and horse traders," Shalu comes up with an interesting quip.

"The sinking air gets warmed up as it nears the ground. It presses all around. Some of the air flows back to the doldrums. The movements are steady, uni-directional. They are called the trade winds. Behind the name lies the old phrase *to blow trade*. It means, to blow steadily in one direction. Some of the air moves towards the poles and becomes the Westerly winds. The Westerly winds run into the Easterly winds blowing from the poles. The Easterly winds are cold and dense. No wind moves along straight lines..." Uncle stops.

"Crooked they come and crooked they go. Very much like rivers and men," I remember a quotation.

"What is in your head?" Uncle asks.

"He sometimes talks out of context. His head needs to be examined. The question is, who should examine his head?" Shalu takes a dig at me.

I catch her long plaited hair. She tries to scratch me with her nails. Uncle pulls us apart and jokes, "I want to keep some air between you two. Shalu! You asked who should examine Ranga's head. I don't think he needs any medical examination. He is perfectly sane. He does not need a psychiatrist. There is another name for the psychiatrist. He is called the head shrinker," Uncle explains.

"He needs just that. He is getting a swollen head," Shalu laughs her head off.

"It won't take me a minute to wipe that smile off your face," I grind my teeth.

Uncle puts us down with words, "Blessed is the peace maker. The peace maker never works along crooked paths. Ranga! You talked about rivers and men going crooked. You know why? They take the easy route. They choose the path of least resistance.

The winds too do that. They do not move straight ahead from north to south or south to north. They curve with the rotation of the earth around its axis. They spin to the right as they head north or south in the northern hemisphere; and left when they head toward the north or south in the southern hemisphere.

"Some move clockwise; some anti-clockwise. Am I right?" I think I have got the right word to describe the motion

"Right, my boy," Uncle gives me a nod and then says. "These movements influence weather strongly."

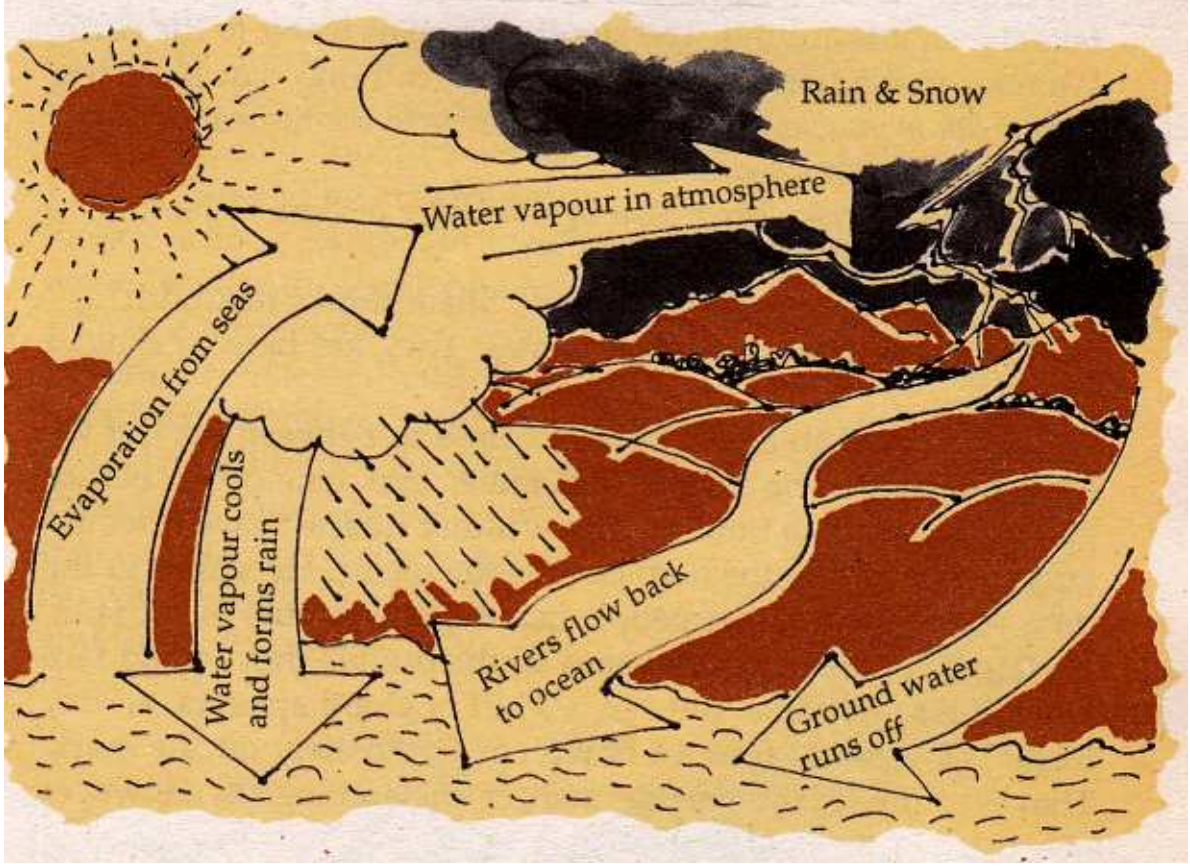
Wind and Weather

Shalu and I sharpen our ears. Uncle continues, "The winds

circle the earth. During their movements, the winds carry anything that they can pick up."

"Air loves to take anything or any one for a ride," Shalu quotes Uncle.

"These rides are for free. The winds need the riders to influence the weather. I will give you an example. Have you heard of dust storms? Winds which roll over deserts carry a lot of dust and sand. They hit the areas around India's capital during summer. Riding them are dust and sand collected from the Thar desert of Rajasthan. Dust hovers in the air. Visibility becomes poor. Sweltering heat reigns supreme. Life becomes miserable for all living things. Human beings try to avoid being out in the open, as much as possible. Animals and birds seek shades of trees. Plants droop and wilt.


Rain & Snow
Water vapour in atmosphere
Evaporation from seas
Water vapour cools and forms rain
Rivers flow back to ocean
Ground water runs off

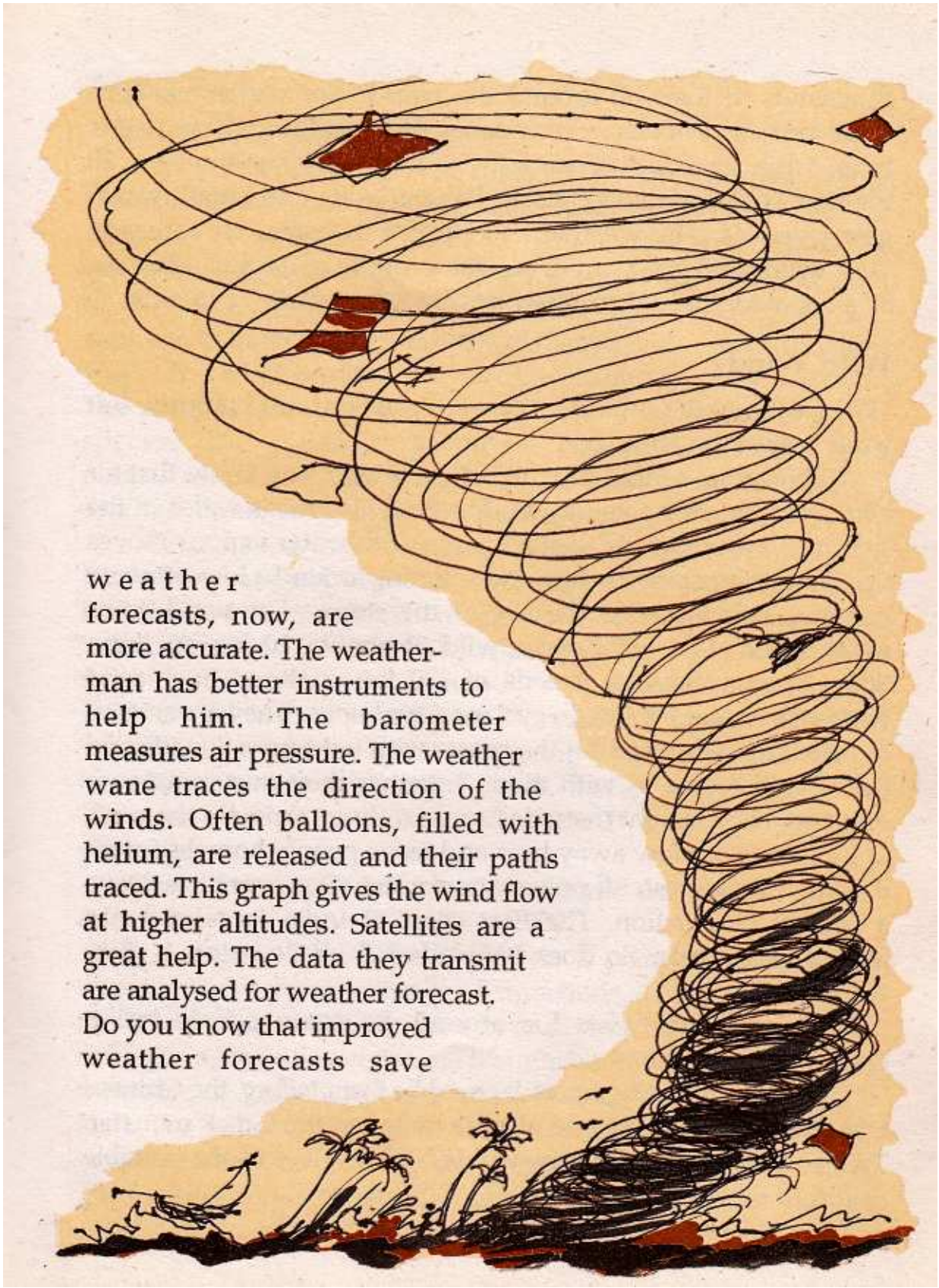
"What about the rains? During the hot summer days, the sun beats down on oceans and lakes and rivers. The heat is intense. Water evaporates. You know what the means? Water turns into water vapour. Water vapour is a gas. It rises into the air. It goes dancing with other gases. More and more water vapour ride the winds. They go over hills and plains. The water vapour cluster together to form dark clouds. The clouds go with the winds. They lose heat. The water vapour turn back into drops of water or snow and ice. The winds herd the clouds, along, very much like a shepherd keeping his flock together. The clouds descend rapidly. They shed some weight. The water in the clouds come down as rain or snow or ice or sleet. The wind moves on, taking rain to far away places. That is how nature recycles the water. The sun and the winds are handmaids of nature. The sun turns water into water vapour. The winds take the clouds around. The clouds return as water to the earth. We refer to the rainy season as monsoons. I may say, *If summer comes, can monsoons be far behind?* The cycle continues for ever," Uncle enjoys the narration.

"I read a book, *Three Men in A Boat* by Jerome K. Jerome," I stop as Shalu cuts in edgewise.

"That is one Jerome too many," Shalu thinks that odd.

"Shut up. Don't question names. They are here to stay," I snipe.

"There you go again," Uncle comes in between us, lest we have a tiff. Then he says, "I remember that. One of the heroes plans a picnic on a Sunday. The weather forecast says it would rain on Sunday. So the hero cancels the picnic. He stands at the door and watches other people heading toward the picnic spot. He laughs at them. He imagines all the trouble they would face when the rains come. But not a whiff of cloud appears, all day long. The weather forecast is wrong. Completely off the mark. That is a dig at the weathermen or meteorologists. However



weather forecasts, now, are more accurate. The weatherman has better instruments to help him. The barometer measures air pressure. The weather wane traces the direction of the winds. Often balloons, filled with helium, are released and their paths traced. This graph gives the wind flow at higher altitudes. Satellites are a great help. The data they transmit are analysed for weather forecast. Do you know that improved weather forecasts save

thousands of lives all around the world? For winds can turn wild, end as cyclones or hurricanes or tornadoes. These winds often whip up tidal waves that rise and fall by as much as 30 metres. They are dangerous to fishing boats and small ocean-going vessels. The weatherman studies the data. He forecasts wild winds and tidal waves at least a couple of days in advance. So people are not taken unawares by wild winds," explains.

Wild Winds

"Wild winds are nothing but air splashing around angrily. But what makes the air angry?" I wonder.

"The sun is behind the fury of the winds. You know that air above the equator gets heated. The heat also turns water in the seas into water vapour. Hot air laden with water vapour moves up. The hot air starts circling and spinning around a low-pressure column. This is called the eye of the storm. The wind gains more speed. The wind turns wild at about 120 km an hour. Some storms move at speeds of 300 km an hour. Such wild winds carry many names... cyclones, typhoons. They are several hundred km wide and hit the coasts with wild fury. Squalls and heavy rains come in with them. Together they cause immense damage..They uproot trees; destroy standing crops; rip the roofs of buildings or blow away huts and leave people homeless, tear down bridges, wash off railway tracks, cut off power lines, leave a trail of destruction. The East coast of India faces cyclones almost every year. So does Bangladesh," Uncle paints a gory scene.

"The cyclone twists life around. So some people call it *twister*" I comment.

"So is the name typhoon. It could be from *taifeng*, the Chinese term for big wind. It could also be traced to the Greek monster, Typhoes, the father of stormy winds," Uncle gives us the possible origin of the word.

Angel Face

"The wind is a demon," Shalu says.

"Wind has two faces... one demonic, the other angelic. Many plants and trees look upon the wind as an angel. Why? Because the wind keeps the species alive," Uncle says. "Every plant or tree wants the seeds to be dispersed. If too many seeds fall close to the plant or tree, there will not be enough space for the saplings to grow. Wind helps the dispersal of the seeds in many ways. The wind brushes over the flowers and steals pollen dust. The wind takes the pollen dust along to another flower of the species. The pollen drops on the flower. The flower gets pollinated. Soon the petals fall off. The flower turns into a fruit or a nut. It holds the seeds for more plants.

"Orchid seeds are very small. So are the spores of moss or fern. They are tiny specks which go with the wind, over hundreds of kilometres. Then they settle down and put in roots. Seeds of dandelions or thistles or cotton have fluffy coats. They fly with the wind and find new homes. Some plants, like the tumbleweed, wither after the seeds mature. The plant dies. The wind turns it around; or takes it along on short flights. When the old plant hits the ground again, the seeds get dispersed. They grow up at the new sites," Uncle tells us how wind helps plant life.

"Does the wind help animals and birds and insects?" Shalu asks.

"Of course. Watch the spider on a plant. It spins silken threads. These threads float in all directions. And the wind takes the spider along with the threads to distant homes. The spider manages a free ride every time it shifts homes. The wind carries the scent of food. Birds and animals trace the scent and find food. The police detectives have trained dogs. The dogs pick up scents better than us. They are brought to the site of a crime. They sniff around. Often they sense the scent the criminal has

left in the air. The dogs trace the scent all the way to the criminal.

"Bird knows how helpful the air is. Bird pushes the air with the wings to fly. It flaps its wings for some distance. Soon, it runs into an air current. It stops flapping its wings. Instead, it glides with the current. This glide is smooth. It is a free ride. The bird uses this time to regain strength. It rides on till the current weakens. Then it resume flying.

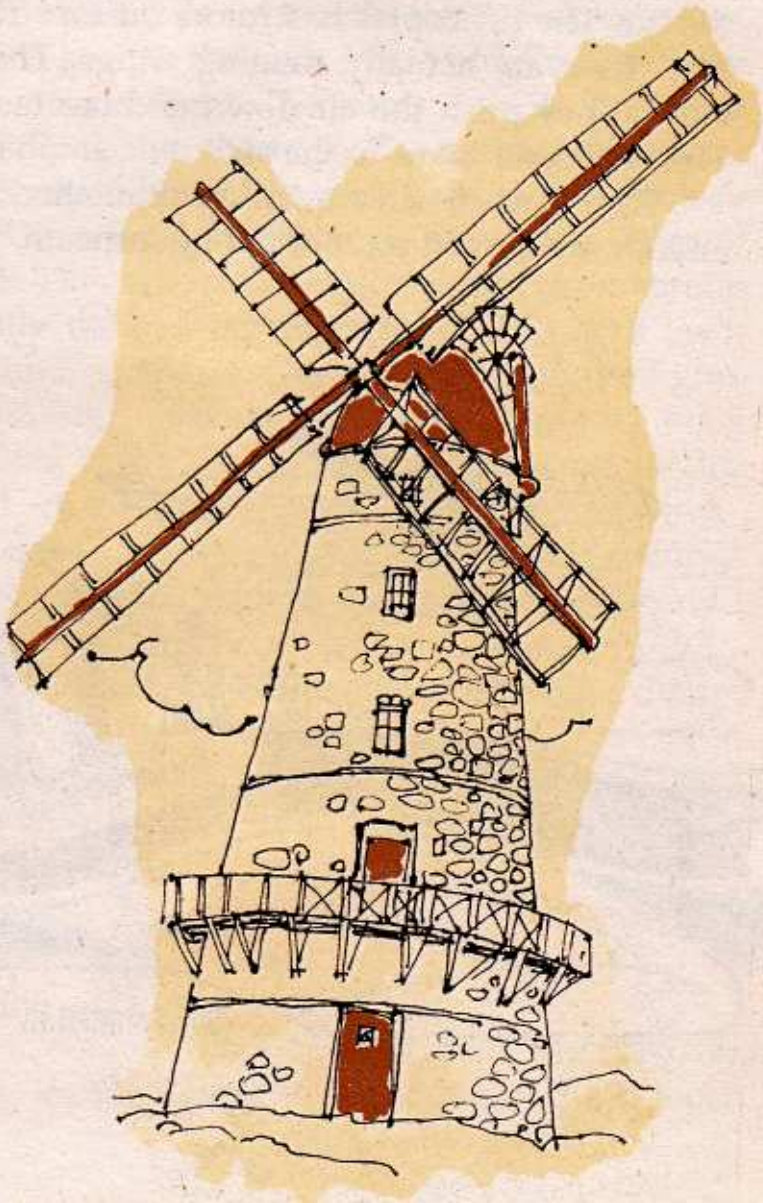
Many migratory birds cross the seas, some times winging their way through, sometimes riding the air currents. Man has taken the cue after watching the birds. Now gliding in a very popular sport for many people." Uncle says.

In the Service of Man

"So wind is an angel. With its help man can glide like birds," I remark.

"The wind works for us in many ways. How we make it work depends on our ingenuity. Ingenuity is another name for human intelligence. Thousands of years ago, man learnt how to make wind work for him. He rigged sails. The sails went up on boats or ships. The sails were adjusted to take in as much wind as possible. Thus man crossed large lakes, sailed the oceans and moved from one continent to another. He made windmills. The wind provided the energy for the mills to turn grind stones. The windmill ground grains into flour. Now giant wind mills produce electric power," Uncle continues.

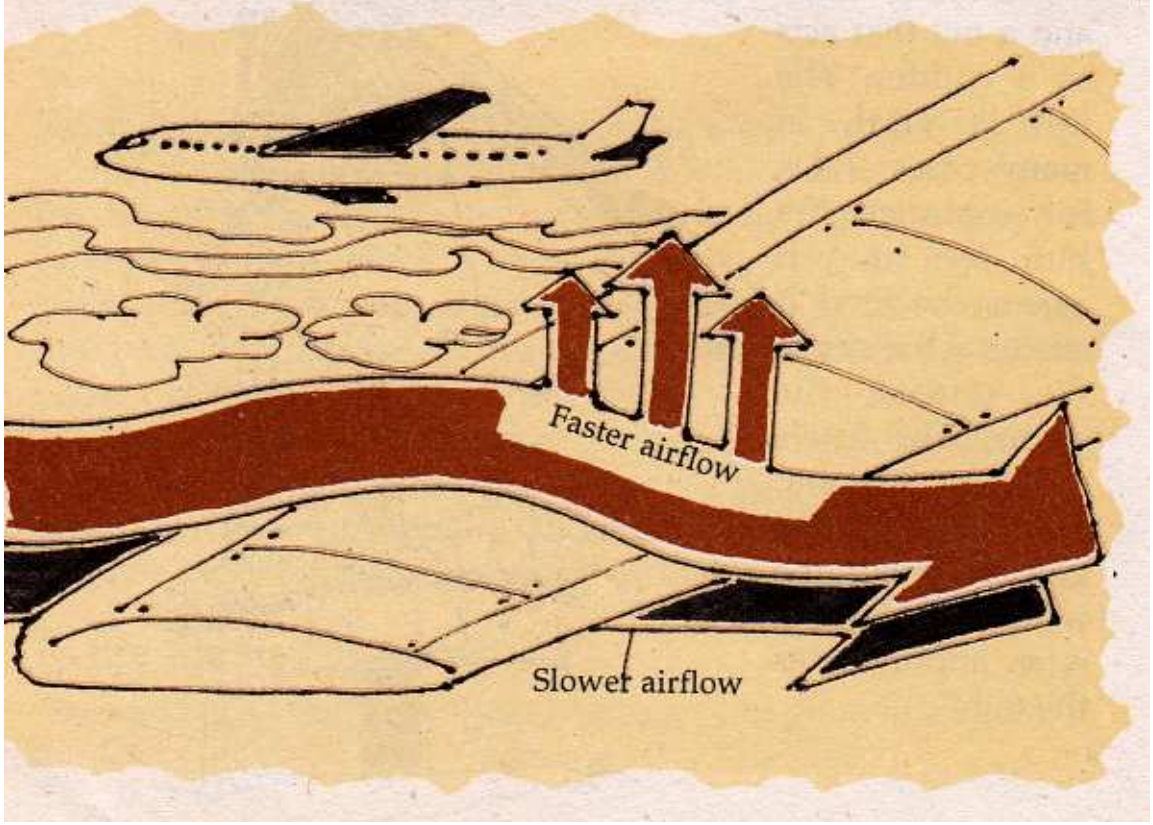
"The windmill has rotating arms; and a tail that acts as a rudder. The tail is vital, in many cases. Take, for instance the kite. We hold it against the wind. It strains at the string. We release the string. The kite's tail flaps around. The kite glides gracefully with the wind. The string is as important as the tail."



"The string lays the ground for the battle of the kites. When the string of my kite snaps the string of another kite, I feel right on top of the world. I watch the other kite dip; or wander aimlessly," I add.

"But it is air that keeps the kite up in the air. It is wind which takes the balloon along its path or turns the weather vane and gives out the direction of its flow. This helps in weather forecasts. Aircraft and helicopters get the required thrust from the air. The helicopter has rotors on top. The rotors spin very fast. They are actually rotating wings. They beat against the wind. They push the air down and create an upward thrust. The helicopter takes to the air.

"The aircraft tries a different method. The wings of the aircraft are curved on top, flat underneath," Uncle pauses.



"How does that help?" I ask.

"The shape of the wings is very important. Behind the shape lies a principle. The speed at which air moves along the top is faster than that at which it travels along the flat bottom. The high speed of air movement on top reduces the air pressure. As a result, a lift in produced. So the aircraft remains airborne."

Artistic talent

"So air goes well with science. Is air an artist too?" Shalu observes.

"Of course. Wind sculpts the rock. Wind picks up grains of sand and takes them on a flight. The sands fly with the wind. The wind runs headlong into the rock. The grains rub against the rock. Usually rocks have soft layers, packed side by side with hard layers. The wind tests the rock. The grains of sand polish the hard rock. They scoop out the soft rock. This continues for centuries. Finally the soft layer crumbles. The hard layer stands. Watch the final sculpture. One can make out the figure of an elephant or an eagle or some other animal or bird. Look out for wind-sculpted figures when you go to the mountains next. Then you will see the masterpieces sculpted by the wind," Uncle gives us a reason to take a holiday in the hills next summer.

"Take us to the hills. That shall be our slogan," Shalu and I shout.

"Or to the desert. Wind paints the desert with sand dunes. It tip-toes over the sand dunes, etches fine lines and curves on sand and shapes huge paintings, perfect in every respect. I see a magic touch in every work of art that wind produces," Uncle sings the praise of the wind.

Magic Touch

"Is there magic in the air?" we ask.

"Of course. I know a few tricks. Here is one. I can make air lift a pile of books, if only I have a plastic bag," Uncle looks

upto us. I fetch a plastic bag. Uncle places it on the table so that its open end hangs off the edge of the table. He tells us to place half a dozen thick books on the plastic bag. Then he holds the open end of the bag. He gathers the edge till the opening is small, just big enough to be blown into, and starts blowing air into it. The pile of books rises, slowly. The books now sit about an inch above the table. The plastic bag holds the books up. Uncle seals the opening with his hand and tells us, "What is holding the books up?"

"Air within the plastic bag. That is magic, indeed," we clap our hands.

Uncle's eyes fall on the bottle with the narrow neck. He stretches the neck of a balloon and slips it over the neck of the bottle. The balloon droops on one side. "The bottle will inflate the balloon," Uncle says.

"Impossible," Shalu is impulsive. I keep my thoughts to myself.

Uncle goes to the kitchen. A little later, he returns with a bowl of boiling water and a peeled full-boiled egg. Uncle places the bowl of water on the floor. He picks up the bottle with the cap of balloon and rests it in the bowl of hot water. "Watch," he says. Our eyes rivet on the balloon. It lifts its head, as if waking up from sleep. It no longer sags. Instead it begins to fill up. Soon it is fully inflated.

"Where did the air come from?" Uncle asks. Nobody replies. Then Uncle says, "Heat expands bodies. The air inside the bottle felt the heat. The heat came from the boiling water in the bowl. The air inside the bottle expanded. It rose up the neck of the bottle. It found space in the balloon and ran into it. Thus the balloon was inflated. What happens if I take the bottle out of the hot water?" Uncle takes the bottle out of the bowl and keeps it in a corner.

The balloon droops. It sags because the air has sunk back

into the bottle.

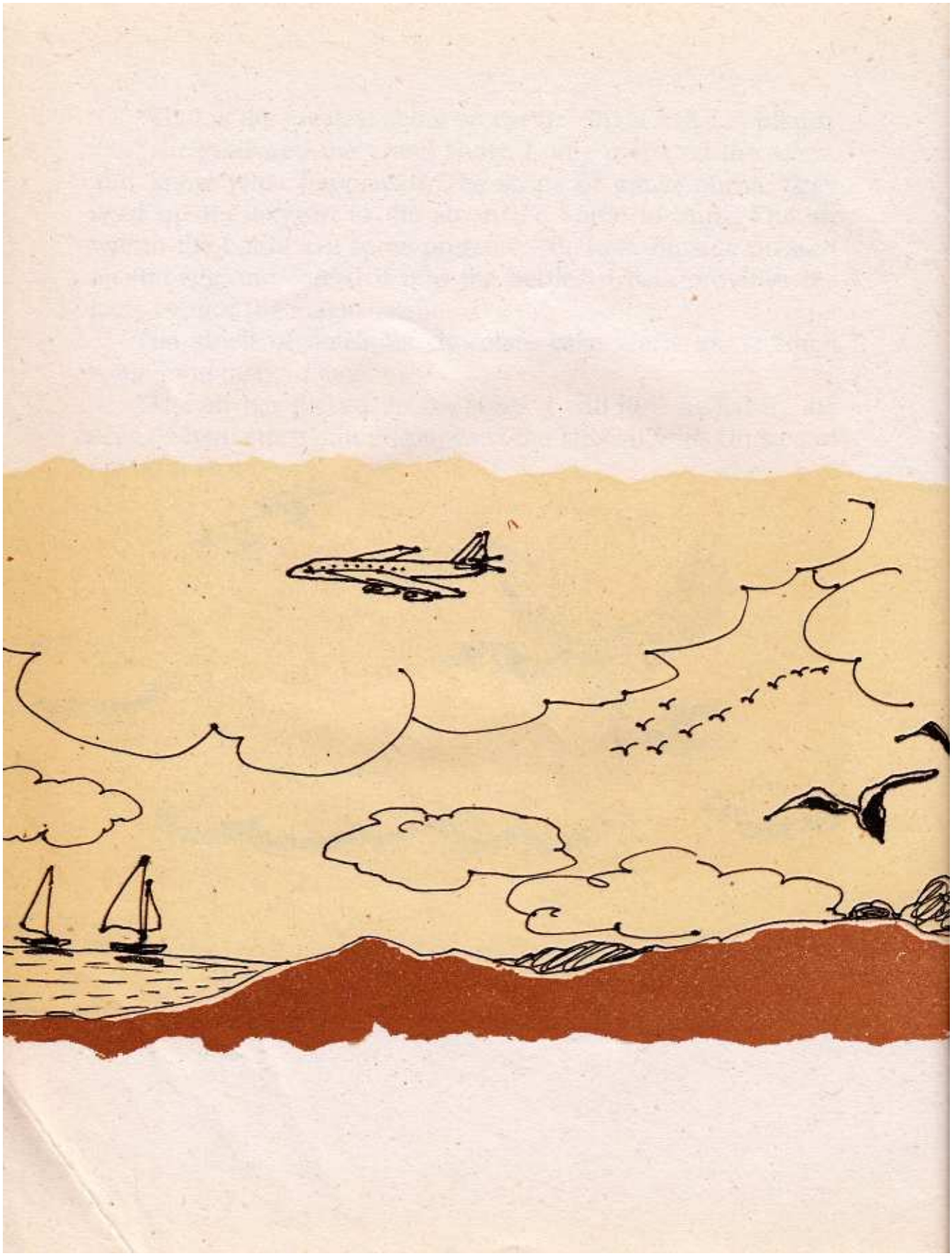
Uncle then announces, "Now comes the egg trick. The bottle will suck the peeled boiled egg," Uncle removes the balloon, places the egg in the neck of the bottle and checks it. It fits into the neck, yet it does not fall through. He pulls it out, hands it over to me to hold and instructs Shalu to get him scraps of paper and a match box. Shalu brings an old newspaper and the match box. Uncle shreds the paper. He drops the strips into the bottle. They settle at the bottom of the bottle. Then Uncle lights a match stick, drops it into the bottle. The strips of paper catch fire. Uncle snatches the egg from my hand and places it in the neck of the bottle, quickly. We watch with wide open eyes. The egg begins to slide down the neck. Then it goes right down to the bottom of the bottle.

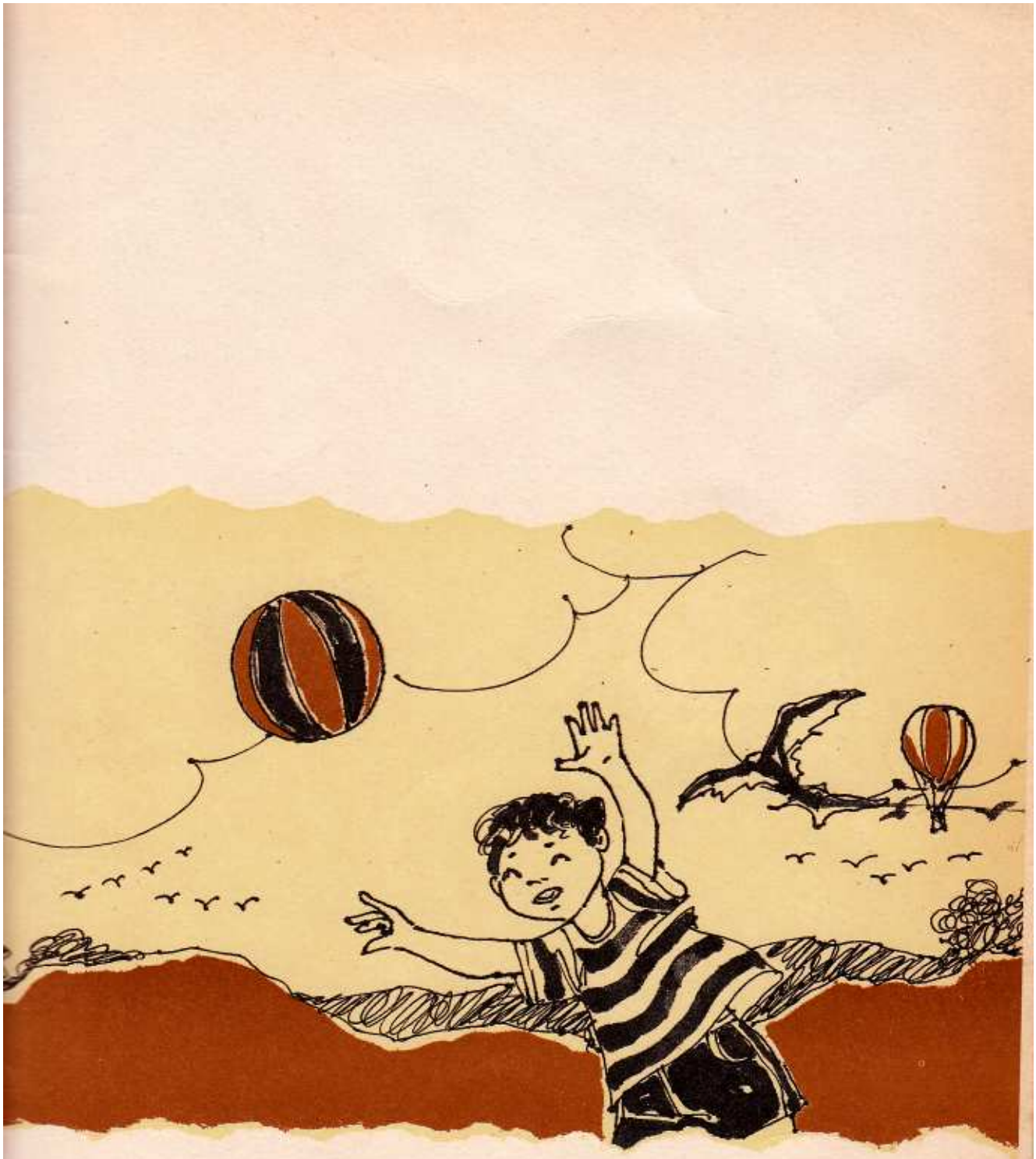
"That is the greatest show on earth." Shalu and I applaud.

"Air produced the grand show. I only prepared the scene. You know what happened? The strips of paper burnt. They used up the oxygen in the air in the bottle to burn. The air within the bottle lost some pressure. Air from outside pressed on the egg and forced it into the bottle," Uncle provides the logic behind the magic.

The smell of delicious chocolate cake wafts in. "I smell something tasty," I say.

"The air has picked up the smell. I will now be led by the nose," Shalu starts running toward the kitchen with Uncle and me on tow.





Laser typeset at Capital Creations, Munirka, New Delhi and
printed at Aravali Printers & Publishers, Okhla, New Delhi

Rs 15.00 ISBN 81-237-2822-0

NATIONAL BOOK TRUST, INDIA